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To Messrs. Thos. T. Wierman, Hamilton Alricks, A. L. Roumfort, Wm. C. Kepner, Wm. Rutherford, J. W. Wier, B. F. Etter, A. J. Whitney, Dan'l D. Boas, D. Eppley, Jno. H. Briggs, Wm. F. Bay, George R. Bolton, G. W. Reily, and others.

Gentlemen:—At your request I have examined the general characteristics of the supply of water for the City of Harrisburg, and herewith submit some conclusions for your consideration, as to the

Present and Future Demand,

District to be Supplied,

Extent and Value of Present Works,

Desirable Improvements, and

Estimates of Cost.

Very respectfully yours, &c.,

SAMUEL McELROY,
Civil Engineer.

Brooklyn, May 21, 1870.

Report.

PRESENT AND FUTURE DEMAND.

The quantity of water desirable for use is determined, as a general rule, by the extent of population and the probable ratio of its increase for a certain term of years, assuming that the usual experience of other cities, in average rate of use per person, may properly be applied to this enquiry, which meets us at the outset.

It appears from the proper statistics, that your city has increased from a census of 5,980 in 1840, to 13,405 in 1860, and has now an estimated number of 30,000: the rate for the past ten years somewhat exceeding 100 per cent. If then, we assume, as is entirely proper, under the favorable location and business circumstances of Harrisburg, that the same rate of increase will be realized for twenty years to come, the number in 1880 will be about 60,000, and in 1890 about 120,000.

Under conditions which tend somewhat to restrict the average daily use of water, your city is now consuming about forty gallons per person. The experience of large cities, with improved supplies, goes to show that fifty gallons is a moderate standard of use; while in some cases, as in New York and Boston, at times, the rate may reach ninety gallons per person per day. In my own practice, however, I have generally assumed the proximate rate for estimating at fifty gallons; and that the judicious use of metres, at certain sources of greatest waste, will tend to keep the average rate at this standard in actual practice.

For the river supply then—the present control of a daily supply of about 1,500,000 gallons, with convenient facilities of increase to about four times this amount; and with a safe provision for contingencies to the works from natural or accidental causes—is all that is now desirable.

DISTRICTS TO BE SUPPLIED.

The City of Harrisburg proper is situated on a low parellelogram, bounded by the Susquehanna river on the west, on the northerly side by the more elevated grounds and ridge in the vicinity of Camp Curtin, and on the easterly side by the high grounds bordering on Paxton creek; and it is now supplied by the reservoir on Capitol hill, centrally located, with an elevation of ninety-one feet above the river, about two thousand feet distant from it.

The area which can be controlled from this reservoir now contains the great majority of the inhabitants and is sufficient in extent, when developed to usual city occupation, to contain about 120,000 persons.

On the northerly suburb of the city, the upper ridge, at and beyond Camp Curtin, has a summit elevation of about 112 feet above the river, distant about one mile from the reservoir, with a district population of two to three hundred at present, which the proposed level of the reservoir will supply for some time to come. When this district has a large population, the question of an independent or auxillary supply will deserve attention.

On the easterly side of Paxton Creek valley, a bold plateau, with a commanding hill, is now occupied by about one thousand inhabitants in a district of ample size for enlargement. An auxillary reservoir, properly to command the future dwellings should have an elevation of about 260 feet above the river; a reservoir for this supply, with an elevation of about 200 feet, and distant about 6,900 feet from the present engine house, has been proposed, as I am informed; in case of the adoption of the latter level for a reservoir, an additional reservoir and system of supply will be in time required. Now, as it seems desirable to provide a supply for the use and improvement of this section, this can be conveniently done from the present works.

Extent and Value of Present Works.

The present works consist of the distribution system as laid; the reservoir on Capitol Hill; two pumping mains and engines, and a substantial and capacious engine house.

The water is now taken from the Susquehanna at a salient point on the river bank, where a good supply of water can always be expected. Opposite and above the engine house, there will be no difficulty in deepening and arranging a channel for the supply of the suction main, so as to furnish cooler and purer water at the rift; and also in constructing an inshore channel, which will intercept the future sewerage discharge of the city north of this point. There is no present urgency for either expenditure, but the facility

for this improvement bears directly on the propriety of the present engine house location.

Two engines are now in use: of these, one has been in use about twenty-nine years, the other being a more recent addition: The old engine having a capacity of about 533,000 gallons per day of sixteen hours, and the other of 1,333,000 gallons; the joint capacity being about 1,866,000 gallons per day, of consumption. Two mains are in use, one of sixteen and the other of eight inches diameter; length about two thousand feet.

The present reservoir is about 150 feet square, with 16 feet water way or depth, containing about 1,500,000 gallons, or one day's present supply. It does not fully command the upper part of the capitol, or of a few other buildings in its immediate vicinity. The reservoir square is about 450 by 550 feet. The distribution is made from the bottom of the reservoir and not from the surface by means of a gate house.

In point of value then, those works have these prominent advantages:—

1st. That they draw water from a healthy and inexhaustible supply by the use of steam power, easily controlled and enlarged, as the city increases.

2nd. That by a short pumping line the water is delivered to a centrally located reservoir, which commands nearly the whole area of present use and future development of the city, up to fourfold the present population, and with sufficient space to increase the storage of water to about five days supply for this number, or about sixteen days supply for the present rate of use as improved.

On the other hand, the works, as now in use, have the disadvantages common to various cities of the union, of not being able to control portions of the more elevated suburbs, and they require some improvements in detail.

Desirable and Proposed Improvements.

It is evident that it is desirable at once to increase and improve the pumping power; to adopt some change in the pumping mains; to increase the reservoir head in the city proper as far as the present reservoir site will permit; having in view the propriety of an enlargement of this structure for greater storage and purer water; and to provide for the supply of Prospect Hill.

As to the present engines, it is evident, on inspection, that an increase of capacity is needed soon, not for immediate action, but as a reasonable precaution against the failure of the old engine, which would leave its mate unable to take care of the demand, and both engines need refitting. It is also evident that an increase and rearrangement of pumping power is desirable for the service on Prospect Hill and for the natural growth of the city

proper. Our usual rule is to provide twice the power actually required, as a matter of precaution. A new engine therefore, of about the capacity of the best present engine, is advised.

At some time about or before 1880, when more than 3,000,000 gallons will be required per day, the proper administration of the supply will then justify the construction of a single first-class beam pumping engine, with a capacity of about 4,000,000 gallons per day of sixteen hours, retaining the more recent engines for auxillaries, as is usual in such cases.

It appears that occasional freshets cover the present engine floor. It will be advisable therefore to bed the proposed new engine, and the others afterward, four or five feet higher; and some improvements are desirable in the engines now in use, to increase their economy and efficiency, for which an item will be added in the estimates.

As the supply of a reservoir on Prospect Hill is advised, and the main at present attached to the old engine is small in caliber and of long use, it will be desirable to lay a new main of twelve inches diameter, for this service, connecting it with the old engine and with both reservoirs by a proper attachment to the sixteen inch main, which can be appropriated to the other engines. The old engine may then be arranged for this auxillary supply, furnished with a new boiler for the additional pressure required, with some convenient reduction of its pump barrel, and other incidental alterations. Either engine can then be connected so as to supply either reservoir. A new air chamber will also be required.

Two distinct improvements seem desirable for the present reservoir and grounds. If the banks of the present reservoir are raised to accommodate fourteen feet more water way or to a level of 105 feet above the river, its capacity will be about doubled, and a sufficient head obtained for the adjacent buildings and the northerly suburb. With the water properly delivered from the surface, by a gate-house chamber, its quality and temperature will be improved.

The reservoir square has sufficient area for largely increasing the water storage, as circumstances may make it desirable: and this fact furnishes a very strong argument in favor of the retention of this feature of the supply as a permanent plan. With a water way of thirty feet, a storage of about 25,000,000 gallons can be secured in the centre of the supply district. The distribution service of a city is generally its most expensive item in water works outlay, and where reservoirs are distant from the centres of use, costly supply and district mains of large caliber are required. The importance of this reservoir site will then be more apparent when it is remembered that, while six inch pipes cost about $1 25 per foot, and stop-cocks $46 00; eight inch pipes $1 57 per foot, and stop-cocks $62; twenty inch mains cost $5 75 per foot, stop-cocks $350, and thirty inch mains $10 per foot and stop-cocks $950. A reservoir centrally located as the present one,

combines various advantages in cost and administration of the daily service, which are of great value to a city.

It is desirable to improve the storage capacity at this point as soon as possible, and to make this improvement in connexion with the present reservoir, so that what is expended on the latter for immediate service will be available on the enlargement hereafter. If, for instance, the entire reservoir square, west of the west bank of the present reservoir, as raised, is constructed as one apartment of a structure eventually to enclose the entire square, an additional storage capacity of about 7,250,000 gallons will be secured, with a head of 105 feet, which brings the capacity at this point up to 10,250,000 gallons, or about seven days' supply for present consumption. A proximate estimate of cost is submitted, in the estimates, based on such information as could be obtained without cross section levels.

For the supply of Prospect Hill district an auxillary reservoir is to be preferred to any other system, and it is desirable to locate this structure so as to command the northerly and westerly grounds of this suburb, which will require an elevation of not less than 260 feet, and a pumping main of about 7,800 feet. If a more elaborate study of this locality should justify a lower location and shorter main, there will be a diminution of cost chiefly in the annual expense of supply.

The use of an auxillary reservoir for portions of a city supply, by steam or water power, so as to avoid the cost of elevating the entire supply to an excessive hight, is a common practice with the hydraulic engineers of Europe and the United States. It is in use in London and other large foreign cities; we adopted it successfully in Brooklyn in 1856, for Mount Prospect; New York is constructing a high service reservoir, above the High Bridge; Georgetown and other cities use the same system; their joint experience going to show the advantage in economy and in administration of this division of head and supply.

In considering the present expenditure on Prospect Hill it must be remembered that there is a prudential limit to the storage capacity of a reservoir, and that too large a body of water in reserve will tend to injure its value, from want of adequate circulation and renewal. In the hot season a storage for a week is better than twice that quantity of water. Depth of water way is also an important element of coolness and exemption from solar fermentation, which has seriously affected, at times, the value of various water supplies about the country. While then, there is wisdom in securing now on the easterly eminence, ample grounds for future reservoir use, there is no advantage, at present, in providing actual storage for any large quantity of water. Grounds should therefore be secured, providing for an enlargement on a scale equal to that of Capitol Hill reservoir, and a single apartment constructed now,

with a capacity of about 2,000,000 gallons, which will give five days supply for 8,000 persons. The cost of the apartment and grounds is included in the estimates.

Under this plan the aggregate storage available for the city and suburbs, will be about 12,250,000 gallons, or more than eight days supply for estimated present consumption.

ESTIMATES OF COST.

The following proximate estimates of cost may be made for the several improvements advised:

Engine House.		
New engine in place,	$15,000	
Refitting old engine, &c.,	5,000	
Contingencies,	2,000	
		$22,000 00
Pumping Mains.		
7,800 feet 12 inch main @ $2 75,	$21,450	
Stop Cocks, Blowoffs and connections,	800	
Contingencies,	2,250	
		24,500 00
Present Reservoir.		
Raising fourteen feet,	$16,500	
Western apartment added, 51,000 yards embankment, @ 50 cts.,	25,500	
4,500 yards puddling, @ 75 cts.,	3,375	
3,500 yards masonry lining, @ $6 00,	21,000	
660 feet Coping, @ $1 00,	660	
700 feet iron railing, @ $4 00,	2,800	
Sodding, &c.,	500	
Gate house inlet, &c.,	5,000	
Division pier,	1,500	
Contingencies,	5,265	
		82,100 00
		$128,600 00
Prospect Hill Reservoir,		
Excavation, &c., 5000 yards, @ 30 cts.,	$1,500 00	
Puddling 1,750 yards, @ 75 cts.,	1,312 50	
Masonry lining 1200 yards, @ $6 00,	7,200 00	
Coping 560 feet, @ $1 00,	560 00	
Railing iron, 560 feet, @ $4 00,	2,240 00	
Gate house and connection,	4,000 00	
Sodding,	250 00	
Fencing,	1,000 00	
Contingencies,	1,937 50	
		$20,000 00
Lands assumed at		5,000 00
Total,		$153,600 00

Of this expenditure, the item of $65,600 for the west apartment of the reservoir on Capitol Hill, can be postponed until some time after the other improvements are in use, when the city will have four days' storage and double the present pumping power.

If these recommendations are carried out, the City of Harrisburg will have secured, for a number of years, a reasonable and satisfactory system of supply, not only for the city proper, as now occupied and in process of increase, but also for the easterly and northerly suburbs, which will tend by their development to strengthen the general interests of the main city.

This result is desirable in a municipal sense, though for a certain lapse of time the water administration itself will be a matter of considerable annual outlay, until the service at Prospect Hill becomes self-supporting, by increase of paying consumers. To illustrate this outlay and income: if we assume the annual expense to be represented by 6 per cent. interest on the cost of the

Pumping engine, at	$10,000
Main,	23,000
Prospect Hill Reservoir,	25,000
Distribution,	20,000
Or $4,680 interest on	$78,000 capital.

And add the annual expense at the engine house, $1,000 and of administration for this district at $1,000 additional, the aggregate is $6,680 per year. With 200 buildings in the district, averaging $5 each, the deficiency would be $5,680 per year, and there must be an average of 1,670 buildings, actually paying $5 each to meet this investment. This general estimate is not, of course, given as anything more than an index of the rationale of this auxillary supply as a matter of financial investment for water income. Considerations of a different order may tend to make this expenditure advisable at present.